AN APPROACH FOR THE DEVELOPMENT OF DOOH-ORIENTED INFORMATION SYSTEMS

Pietro D'ambrosio[1], Filomena Ferrucci[2], Federica Sarro[2] and Maurizio Tucci[2]
[1]*NET FIRST srl – Salerno, Italy*

[2] *University of Salerno,Via Ponte don Melillo, 84084, Fisciano (SA), Italy*

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Abstract: The last years are characterised by an increasing demand of using digital services and multimedia content "out of home". This poses new challenges to software factories in terms of integration and extension systems. In this paper, we report on an industrial research project realized by some ICT companies together with some researchers of the University of Salerno. The goal of the project was to define a new approach for developing Enterprise systems able to integrate traditional applications with Digital Out Of Home (DOOH) extensions. The experience was carried out defining a methodology and some tools to develop such type of systems in an industrial context. The proposed approach was evaluated carrying out two case studies.

1 INTRODUCTION

In the last years there is an increasing demand for using digital services and contents "out of home". Hardware and software solutions that allow users to interact with content distribution systems in public environment (e.g., streets, stations, airports, shopping centres) are classified as a new family of systems named "Digital Out Of Home" (DOOH). In market areas where the competitiveness and attention to the customer is very high, such as the financial/banking and tourism, it has been recognized that these new ways of consuming digital services can be crucial for the continuity and expansion of the business. This results in a growing attention to this kind of products and in an emerging need to evolve the companies' information systems to integrate DOOH features, giving rise to a new kind of systems that we name DOOH-Oriented Enterprise Information Systems (DOOHIS). Some features characterize this kind of systems, such the use of multi interaction devices, multimedia content, multimodal interaction, context awareness. Indeed, the ICT technologies advances of last years make available on the market a great variety of multimedia devices (interactive showcases, interactive tables, virtual or augmented reality systems, etc...) that allow forms of interaction with users more and more fascinating. Moreover, these systems are supposed to execute in a ubiquitous, heterogeneous infrastructure (possibly mobile) and in different execution environments or contexts. They should be able to sense the context in which they are executing and change their behaviour in response to external changes (Inverardi and Tivoli, 2009). Thus, traditional information systems have to be integrated with new "channels", new devices and environmental sensors.

This poses new challenges in terms of integration and extension. Indeed, DOOH features are usually realized employing custom technologies, which make difficult the integration with pre-existing information systems. Moreover, the strong demand of these systems forces software factories to redefine their development process to adapt it to the complexity of these new products. On the same time, companies have to deal with crucial issues critically increased by the current economic scenario and the high competitiveness requested by the globalized market, such as:

- The production of DOOHISs is very expensive since the cost to develop a system exponentially grows with the increase of system complexity.
- The market sector is characterised by high competitiveness and frequently changes in rules.

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- The reuse of software component is very low. This is mainly due to the fact that often the cost of adaptation of these components is too high.
- The strong dynamism of the market. This phenomenon forces ICT companies to a dynamic organization of their staff, also considering the opportunity to take the form of "virtual enterprise".

Starting from the above considerations an industrial research project has been jointly carried out by some Italian software companies and some academic researchers of University of Salerno. The aims of the project were to define a new approach able to reduce development costs for DOOHISs and at the same time improve their quality. The critical aspects to be addressed to achieve these goals were:

- Support the component software reuse;
- Reduce domain application knowledge transfer risks, such as misunderstanding system requirements;
- Automate a significant part of the development process without missing the possibility to manually realize integrations and modifications.

Thus, we defined an approach, named EMAF (Enterprise Multilevel Applicative Framework) which is specialized for the development of DOOHISs. In particular, to realize such systems we proposed an architecture (i.e., EMAF Architecture), a development methodology (i.e., the EMAF Methodology) and a set of tools which support the stakeholders in the various phases of the proposed development process. The approach was employed to develop two information systems for two different application domains, namely financial and tourism.

The remainder of the paper is organized as follows. Section 2 provides a background on DOOH applications and highlights issues and challenges in integrating them in an enterprise information system. Section 3 describes the approach we propose. In Section 4 we describe the two case studies related to the use of the proposed approach and the lessons learned. Some final remarks and future work conclude the paper.

2 DOOH-ORIENTED INFORMATION SYSTEMS

Hardware and software solutions that allow users to interact with content distribution systems in public environment (e.g., streets, stations, airports, shopping centres) are classified as “Digital Out Of Home” (DOOH) applications. The first kind of DOOH-applications was the Digital Signage, ideated to reduce production and distribution costs of paper advertisements in busy environments. The technology and the habits in using such type of systems are evolved quickly to the point to introduce new forms of communication with users and content fruition. At the same time it has been recognized the effectiveness of these systems in improving emotional involvement, attracting user attention and influencing its purchase decision (increases up to 75% were observed) and, more generically, increasing a positive perception of the environment and the brand.

All this has encouraged the ICT sector to search for applications, technologies and modality of use more and more involving and spectacular with the aim to directly interact with the consumer by delivering content personalized and adaptable on the basis of the current time or the specific fruition location. Moreover, the opportunity to reach specific customers in a specific moment has also allowed for customizing and personalizing information and making more comfortable the fruition of services. Thus, the use of DOOH solutions to communicate and to interact with consumers in an urban context or in public environments offers some important advantages in terms of effectiveness and economy of management. Furthermore it allows delivering new services, creating new opportunities of interaction with consumers and new opportunities of business.

The majority of DOOH solutions are able to manage networks of different devices, such as LCD displays, video-walls, and PDAs. Thus, there is the need to realize a sort of dynamic content fruition that allows differentiating the content and the planning for groups of devices, typology of device, geographical area or a single device. These advanced systems should also be able to acquire data from existing information systems and to plan actions based on specific events (e.g., activated by temporal advance, by local devices or by particular information received from the environment). For instance, in the case of an airport, this feature should allow us to relate the displaying of a particular advertisement/information or the start of a specific application to an event such as the opening or the closing of a gate.

The extreme variety of multimedia devices (each one characterized by specific features) introduces new challenges in terms of ability in using them and integration with specialized applications. These difficulties together with the need to contain the development costs determine that in the majority of present solutions the interaction with users is

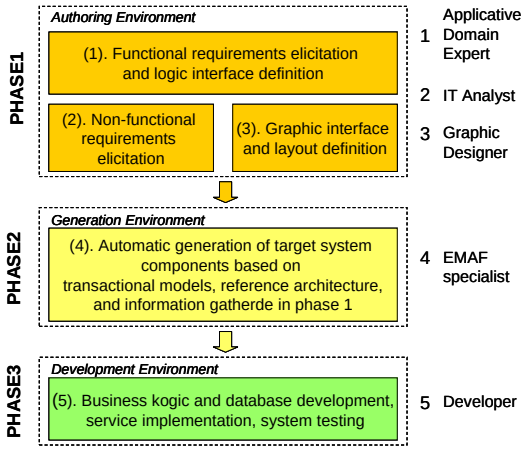

Figure 1: The proposed methodology.

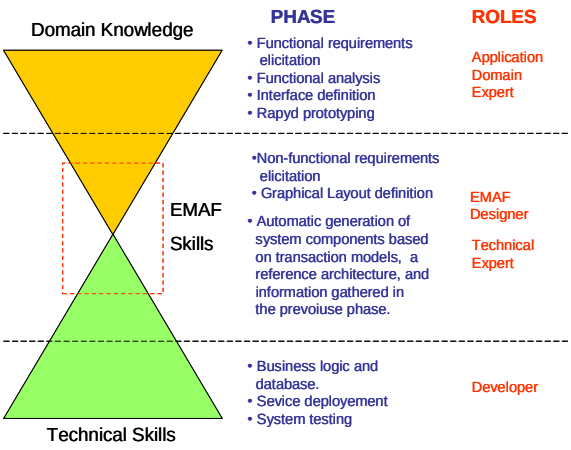

Figure 2: The methodology hourglass.

managed only by dedicated stations which run specific applications. Moreover, few differentiations of the content are realized usually based on static information such as typologies of terminals or their locations. It is obvious that the traditional forms of content management based on palimpsests and planning become inadequate in presence of complex environments or content characterised by high variability. Moreover, it is worth noting that to realize effective content and schedules, an editorial structure composed by people with different and specialized know-how and skills is required with consequent increasing of costs and operational complexity.

Thus, the challenges that are currently presented to the industry of DOOHISs concern the introduction of "intelligence" in the management of complex terminal networks with the goals to maximize the characteristics of content geolocation and context awareness, to reduce the costs of planning of the program schedule, to improve the interactivity with users and to support a greater and easier integration with external systems and technologies.

3 THE PROPOSED APPROACH

To address the issues highlighted in the previous section we propose a solution where a DOOHIS is formed by two different components: an “intelligent” DOOH-application and a web application. The former acts as container, while the latter is a traditional web application that can be executed also out the container. In particular, the DOOH-system manages the devices and sensors network and makes actions on the basis of a defined plan or triggered by specific events and context changes recognized by a smart engine. The web application when it is executed in the DOOH container is capable of interacting with the environment and sending events-messages to the DOOH-system. This event-message can be used to activate computing processes, modify a previously defined plan, or, more in general, modify the state of the system.

As an example, let us consider a video-wall placed in a strategic point to display a multimedia show composed by videoclip, news, advertisement or tourist information. This show can vary on the basis of a specific happening, such as the identification of an RFID tag contained in a tourist card, the recognition of people standing in front of the video-wall and watching the show, a specific request (e.g., a button pressed by the user). Indeed, the DOOH-system is capable to capture several events and to activate for each one a specific web application that provides the user with a set of functionality related to the profile identified. Moreover, when the application is activated the system can choose how display it on the basis of the capabilities (e.g., display size) of the device on which it will be visualized and the priority given to the other running applications. Thus, in the reported example the DOOH-system recognizes the need to start a specific application and decides the way to present it to the final user, while the web application manages the interactive functionalities.

3.1 The EMAF Methodology

To design and develop the described kind of DOOH-oriented information systems we devised a

"multilevel methodology" characterised by the subdivision of the activities in some levels and by a high involvement of non-ICT stakeholders. The proposed subdivision let each professional figure involved in the development process to design a specific view of the system (e.g., graphic interface, menu and interaction style, business logic, ...) using the tools and the interface metaphors more suitable for his/her role. This approach reduces the effort needed to transfer the knowledge from experts of the application domain to technology specialists. Moreover, it has the appreciable advantage to reduce the risk of misunderstanding system requirements allowing an immediate validation of the target system behaviour (interface, page layout, glossary, etc...).

The proposed methodology decomposes the development process in three macro phases (see Figure 1):

1. Systematic elicitation of functional requirements, project design choices, interfaces, business logic, etc. These tasks require the involvement of several professional figures (application domain experts, analyst, graphic designer, multimedia experts, communication experts,...) and are supported by some authoring tools.
2. Automatic generation of software code (i.e. skeleton) on the basis of models and reference architecture and framework;
3. Manual fulfilment of skeletons realized by developers on specific "change points".

Figure 2 shows how the competences are distributed during the software development process. In particular, the middle point of the hourglass highlights a significant reduction of the professional figures with specific technical skills needed to the software factory to realize the products. On the contrary, there is an increasing involvement of application domain experts and system analysts and developers. This aspect is crucial to facilitate a dynamic organization of project teams and to share factory infrastructure between different companies.

3.2 The EMAF System

The EMAF system we designed to support the proposed methodology is composed by several components each one belonging to one of these subsystems: authoring tool, automatic generation tool, run-time environment (see Figure 3). The authoring system is composed by two subsystems: the DOOH Authoring System (DAS) and the Services Authoring System (SAS). The first is used to define the DS/DOOH container, while the latter is used to define the Web application. In particular, DAS (Figure 4) is composed by two main components: (i) the Multimedia Management Console (MMC) employed to manage multimedia resources, to define program schedules and content plans for the various system channels and (ii) the Layout Management System (LMS) employed to define the multimedia container layout and to identify the area where players able to show specific content are executed.

On the other hand, SAS (Figure 5) provides stakeholders with a set of authoring tools which allow defining web application structure and the related logic aggregating information coming from multiple sources. Indeed, several stakeholders can be involved in the development process (multilevel approach) and each of them can use a specific tool to work with the system representation more appropriate to his/her role.

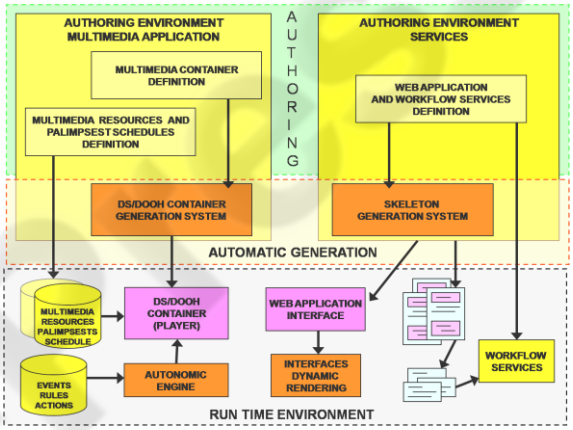

Figure 3: The proposed system.

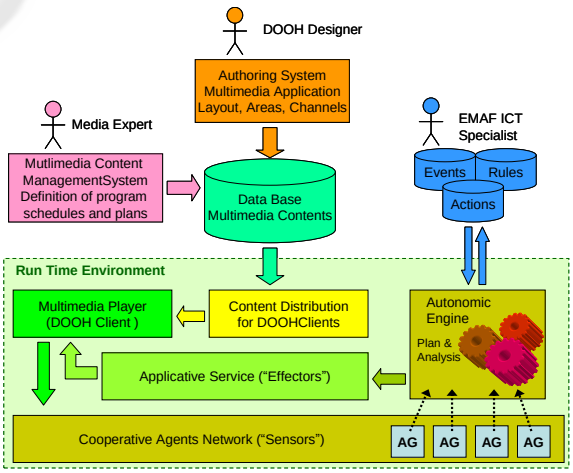

Figure 4: The DOOH Authoring System (DAS).

As an example, Figure 5 shows three authoring tools employed to define the graphic, functional, and technological features of the DOOH-oriented system to be realized. All the information produced by the authoring tools is stored in a centralized repository. This information is used by the generation system to automatically develop pieces of code (i.e., skeletons) that have to be completed by developers to realize system functionality. It is worth to note that the automatic generation is accomplished exploiting component models that are modifiable. This simplifies the system adaptation when the software factory needs to make changes or the use of new standards or technologies is imposed by the customer.

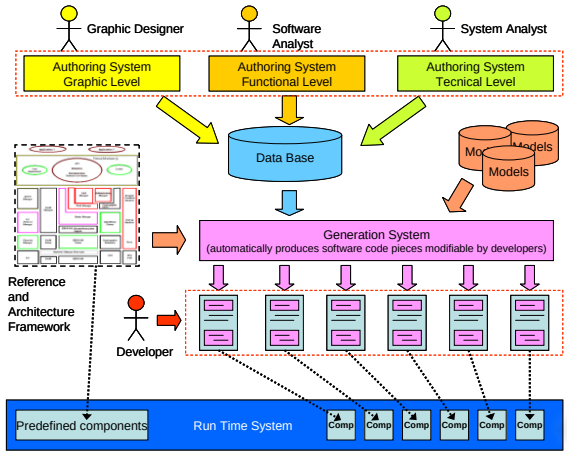

Figure 5: The Service Authoring System (SAS).

The run-time system is composed by some reusable components and by all the components produced by developers starting from the skeletons generated by the system. In particular, based on the reference architecture and framework the following components were employed:

- A component for the dynamic rendering of interfaces which manages at run-time the building of a customized layout for specific users and channels.
- An autonomic engine (IBM, 2006) (Muller et al., 2009) (Brittenham et al., 2007) which makes decisions on the basis of a logic defined by events, rules and actions. In particular, this engine is able to monitor the events collected by a network of cooperative agents (i.e., environmental sensors and interactive devices) and perform the appropriate actions (i.e., execute a specific application services);
- A distribution system which allocates content and applications on the devices belonging to the DOOH network on the basis of program schedules and content plans defined by the Multimedia Management Console.

4 CASE STUDIES

To evaluate the cost/effectiveness of the proposed approach we carried out two case studies. In particular, the proposed approach was applied to develop two DOOHISs for two different application domains, namely financial and tourism domains. Indeed, we believe that in these sectors the application of DOOHISs will grow in the next years.

The first case study is related to a system developed with the aim to improve the relationship between a bank and its customers. Indeed, we developed a DOOHIS to manage the internal and external communication and provided services to the customers through new interaction modalities. In particular, the bank was equipped with I/O devices and environmental sensors which provided the DOOHIS with the information needed to make decisions and supply the appropriate services to each customer. The I/O devices represent "communication channels" and for each device several DOOH functionalities and application services were developed. As an example we introduced the use of an interactive totem which displayed information and multimedia contents following the programs schedule defined by the Multimedia Management Console. The environmental sensors allow the system to recognise whether an user is near the totem and a face detection algorithm is employed to count how many users are seeing the display. Moreover RFID tags contained in customer card, allow the system to univocally identify the customers. This information, together with the ones gathered by environmental sensors (e.g., number of people present in the bank office, current day, time) are exploited by the autonomic engine to decide the more suitable contents to show through the totem suggesting specific contents for the customers and providing him/her with interactive functionalities.

The second DOOHIS was designed to meet the growing demands of digital tourism products, especially for tourism service customizations and integrations of public services (e.g., security, health, transport) with tourist information in urban areas. Indeed, such a system can be used in a city to manage the network of sensors and devices (e.g., multimedia Totem, videowall) employed to offer a service to a final user (i.e., a tourist). The user can interact with the system in various way using his/her

device (e.g., PDA, cellular phone, netbook) or the devices placed in the environment and can use information and services provided in push or pull mode. Differently from the first case study, we extended the type of devices employed to access to the services and experimented interface metaphors to deal with different devices. Moreover, a web application for a tourist assistance centre was developed employing the proposed authoring tools. The application let to collect and manage the requests coming from tourists or a supplier network.

The case studies played an important role in our project since let us to evaluate the industrial employment of the proposed approach and to study the impact that the proposed methodology and systems had on the software factories organization. To this aim, the project team was composed by people coming from the different companies which took part to the industrial research project. This let us to observe the learning times and the methodology effectiveness in a heterogeneous and "not yet consolidated" context. The case studies allowed us to derive the following remarks.

A successfully involvement of non-ICT stakeholders was observed in requirements elicitation and user interface definition phases. Indeed, the involved non-ICT stakeholders found very easy the use of the proposed models.

A consistent reduction of development and testing time was obtained (i) employing a reference framework, (ii) defining the application logic on a set of rules, services and service workflow, and (iii) automatically generating skeletons for software components which have to be fulfill by developers.

Moreover, we observed that the second case study was conducted more easily and quickly than the first one. This was due to the reuse of several components. Indeed, a reduction of lines of code construction to realize system functionality, were observed.

5 CONCLUSIONS

In the paper we have highlighted the challenges that software companies have to address for the development of a new typology of information systems (DOOHISs), whose demand is highly increasing in the last years and that provide great opportunities for business and services. The specific contributions of the paper are:

- The definition of a development methodology for DOOHISs;
- The development of a tool based on the proposed methodology, compatible with a reference software architecture and a reference functional framework;
- The validation of the proposed approach in two application domains, namely financial and tourism, to evaluate whether it is cost/effective in an industrial reality. The demonstrative systems for financial and tourism application domains were characterised by the integration of some application services in a network of devices with interactive digital functionality.

The results achieved were encouraging and motivate further experimentations of the proposed approach with the aim to refine and transfer it to the industrial context. The ICT companies that took part into the industrial research project are introducing in their development processes some authoring components. Systematically collecting feedbacks from stakeholders and comparing them with data acquired by company reporting systems is very useful to have an evaluation of the advantages that derive by employing the proposed methodology.

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